

# APPRAISING VERTEBRATE DIVERSITY ON BONAPARTE ISLANDS, KIMBERLEY, WESTERN AUSTRALIA

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## ABSTRACT

Three expeditions examining 35 islands in the Bonaparte Archipelago along the northwest Kimberley coast were undertaken between August 2002 and June 2005. These documented numerous new records of mammal and reptile species for the islands with the fauna of 27 islands being examined for the first time. Mammals were usually confined to the larger islands adjacent to the mainland and only on East Montalivet and Coronation were populations recorded on more distant islands. Two mammal species were trapped on an unnamed island that was only 23 ha in extent. Reptiles occurred on all islands examined from the smallest (4ha Low Rocks) to the largest (18121ha Bigge Island). The 29 reptile species recorded represent several new records for the Bonaparte Archipelago and includes new localities for many species. Populations of Olive Pythons were recorded on islands as small as 73ha. No frogs were recorded although climatic conditions and the poor wet seasons preceding the expeditions were not conducive to amphibian activity.

## INTRODUCTION

Kimberley islands have been isolated from the mainland for up to 10 000 years as a result of increasing sea levels after the last

Pleistocene glacial maximum at about 18 000 years before present (Nix and Kalma 1972, Hopper *et al.* 1996). Such extended periods of isolation of

islands elsewhere has lead to many populations differentiating into new taxa as evidenced by the islands of the Indonesian archipelago, lying immediately to the north of the Kimberley coast (Schmitt *et al.* 1995, Kitchener and Suyanto 1996), Pilbara coastal islands (Abbott and Burbidge 1995, Smith 1976) and Bernier, Dorre and the Houtman Abrolhos off the west coast (Ride and Tyndale-Biscoe 1962; How *et al.* 2004).

The documentation of the mammals, birds, amphibians, and reptiles of the Kimberley region of Western Australia has progressed at very different rates. Storr (1980) regarded the quarter century beginning in 1886 as the 'golden age' of Kimberley ornithology. All but a few of the birds now known from the region were made known to science in that period. The first, and relatively complete, list of mammals from the Kimberley was compiled by Dahl (1897) within two decades of the first European exploration of the region. While our understanding of the diversity of the birds and mammals of the Kimberley was largely complete by the end of the 19<sup>th</sup> Century, an understanding of the herpetofauna had barely begun. Most of the herpetofauna was described in the 20<sup>th</sup> Century and over a third has been described since 1960.

The extensive array of biological surveys conducted during the 1970's (Miles and Burbidge 1975;

Kabay and Burbidge 1977; Kitchener 1978; Burbidge and McKenzie 1978; Western Australian Museum 1981) added substantially to our understanding of the distribution of the north Kimberley vertebrate fauna. These surveys lead to a far better understanding of the composition, habitat preferences and biogeography (McKenzie 1981) of most vertebrate groups of this tropical area, particularly mammals, and permitted a reappraisal of the taxonomy of numerous species (Kitchener and Humphreys 1986, Kitchener and Sanson 1978, Kitchener and Caputi 1988, Kitchener 1976, 1989, Storr 1975). The major rainforest survey of the late 1980s (McKenzie *et al.* 1991) and continued sampling activity in the region has shown that the area covered by the 1:250 000 map sheets of Cambridge Gulf, Montague Sound and Prince Regent in the north Kimberley are the richest for frogs, mammals and reptiles in all Western Australia (How and Cowan 2006).

In contrast, the fauna of Kimberley islands is poorly documented and there has been only one published survey of these islands (Burbidge and McKenzie 1978). This reported on some 20 islands in the Bonaparte Archipelagos of the northwest Kimberley that were surveyed for between 1 and 11 days. Islands in the Buccaneer Archipelago in the west Kimberley were also surveyed by government

biologists briefly between 1980 and 1982 and results remain mostly un-published (but see Abbott and Burbidge 1995), however, the fauna of Koolan Island, also in the Buccaneer archipelago, has been documented in detail by McKenzie *et al.* (1995). Information gathered on these island surveys, later visitations by individuals and the major rainforest survey (McKenzie *et al.* 1991) as well as specimens in the collections of the Western Australian Museum, indicate that at least 5 frog, 34 mammal and 58 reptile species are present on the offshore islands along the Kimberley coast. This is in marked contrast with the 26 frogs, 72 mammals and 109 reptiles known from adjacent areas of the mainland. None of the offshore island populations have been examined systematically and all populations, except *Ramphotyphlops* sp. and *Lerista praefrontalis*, have been referred to mainland taxa in published reports.

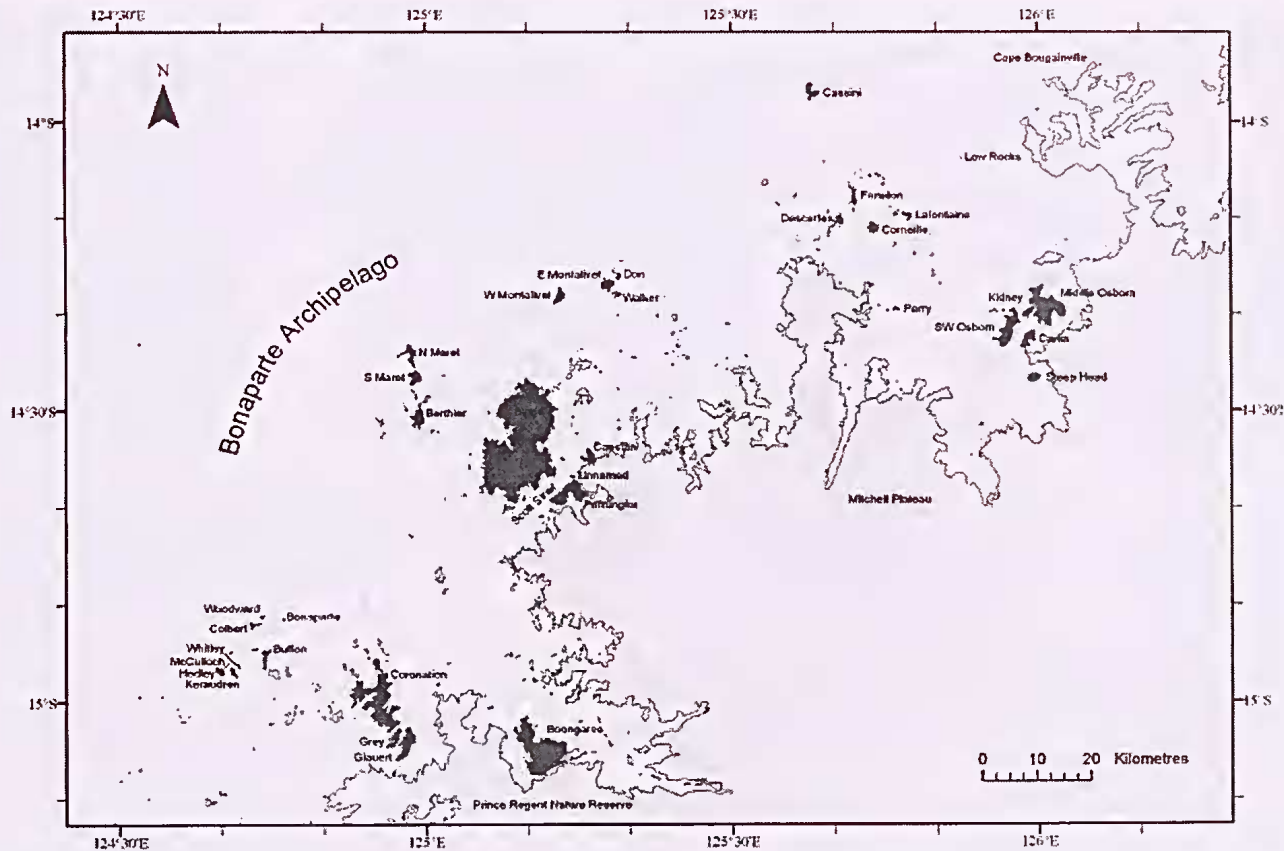
Our understanding of the identity of vertebrate faunas on the Kimberley islands also stands in sharp contrast with the detailed knowledge of island archipelagos off the Pilbara and western and southern coasts of Western Australia, all of which have been separated from the mainland for similar periods of time. Many of Western Australia's more southern islands have vertebrate populations that are distinctive at the subspecific level, and in some cases at the

species level, from populations on the adjacent mainland. All endemic insular taxa are recognised as threatened fauna either by legislation (Government of Western Australia 2005) or by Department of Conservation and Land Management authorities under the Priority Species List.

This paper reports on the outcomes of three expeditions to 35 Kimberley islands in the Bonaparte Archipelago undertaken between August 2002 and June 2005. These surveys were designed to make collections and document the frogs, mammals and reptiles from selected islands in order to determine the morphological and genetic attributes of island and mainland populations. These studies will permit an evaluation of the systematic status of many insular populations and contrast these data with published information available on vertebrates from cognate archipelagos off the Pilbara and west coast of Western Australia. The project will also appraise the evolutionary processes involved in differentiating island forms and assist in determining whether populations are relictual or derived from colonisers from adjacent islands or the mainland.

## ISLANDS AND METHODS

Islands were selected on the basis of their geographic location with islands representing those both distant from and adjacent to the mainland being selected.



**Figure 1.** Map of island and mainland locations sampled during the survey of the Bonaparte Archipelago between 2002 and 2005.



Likewise, islands of different sizes were selected as well as those consisting of the main sandstone, volcanic or laterite geological substrates. Wherever possible, a wide variety of vegetation types were sampled on each island with both woodlands and vine forest being targeted.

Thirty-five islands were examined over the three expeditions along with two locations on the mainland; one with three sites adjacent to Scott Strait during the June 2004 survey, the other with three sites opposite Glauert and Boongaree Islands, during the June 2005 survey. For each of these locations, the data for the sites have been aggregated.

The islands sampled are shown in Figure 1, while their area, broad geographical co-ordinates, principal geological formations and duration of sampling are presented in Table 1. Nine of the islands sampled during this project [South West Osborn, Middle Osborn, Carlia, Low Rocks, East Montalivet, South Maret, Bigge, Coronation, Boongaree] were also sampled in the early 1970s (Burbidge and McKenzie 1978) with specific information on their geology, vegetation and vertebrate fauna presented then. On South West Osborn, Bigge and Boongaree Islands, sampling during this survey was carried out on both volcanic and sandstone substrates, while on Carlia Island only sandstone substrates were sampled.

Previously assessed distributional data for the amphibians, reptiles and mammals were obtained from the literature (Burbidge and McKenzie 1978; Abbott and Burbidge 1995) and the State's collections housed in the WA Museum.

General rainfall and climate patterns in the northwest Kimberley are presented in Burbidge and McKenzie (1978), an area characterized typically by a 'wet' season extending from December to April and a 'dry' season from May to November. Rainfall averages over 1500mm at Mitchell Plateau and is concentrated in the 'wet' season. During the present expeditions, the wet season of early 2002 was one of the driest on record, and those for 2004 and 2005 were also well below average.

The charter vessel 'Barra B' was used as a base for visitation to all islands sampled. Access to the islands was by outboard runabout and predicated by both shoreline type, weather conditions and tidal activity that ranged up to ten metres.

## SAMPLING

Sampling occurred on three separate expeditions between 25 August – 6 September 2002, 26 May – 8 June 2004 and 19 May – 3 June 2005.

On each island where one or more nights trapping occurred (Table 1), sample sites were trapped using a line of between 20 and 25 Elliott Type A traps, baited with

universal bait. These were set around 10 metres apart. A few Elliott Type B traps were used on some lines and wire mesh Tomahawk cat traps were also employed where sampling continued for several days and there was the prospect of catching larger mammals. Traps were checked during the morning each day. No concerted effort was made to trap bats by mist netting or harp trapping. Opportunistic collecting of vertebrates was undertaken on all islands visited and involved active searching in litter and dead wood as well as under rocks and logs. Head-torching for nocturnal species was conducted on several islands and small pitfall traps were employed on Cassini, Descartes, North Maret, Buffon Islands and the mainland opposite Scott Strait.

Voucher specimens were taken of all taxa for use in later analyses of morphological and genetic variation of vertebrates from the Bonaparte archipelago. Numerous individuals, particularly mammals, were released after weighing and removal of tail or ear tip for later genetic examination.

## RESULTS AND DISCUSSION

Sampling on the islands and adjacent mainland sites during the three expeditions documented 2 amphibian, 12 mammal and 29 reptile species.

### AMPHIBIANS

Two species of frogs were

collected, *Litoria copelandi*, *L. meiriana*, both from the mainland on Prince Regent Nature Reserve adjacent to Glauert Island. None of the islands examined had frogs present and a general lack of freestanding water on the vast majority of islands and the 'poor' wet seasons associated with the sampling time probably account for this low documentation of amphibians.

Previous surveys have identified four species of frog in the Bonaparte Archipelago, *Notaden weigeli*, *Litoria rubella* and *L. inermis* from Bigge Island and *Cyclorana* sp. from Katers Island (Smith and Johnstone 1978).

Frogs are particularly poor survivors on small islands and ineffective dispersers across sea-barriers.

### MAMMALS

Mammals were collected from 11 of the islands and the two mainland locations during the survey (Table 2). In total, 394 individuals of twelve species were captured and identified. The sighting of a small rock wallaby on Boongaree Island probably represents the previously recorded and collected *Petrogale burbridgei*, while scats and diggings of echidna, *Tachyglossus aculeatus*, were very common on Boongaree but only one positive sighting was made.

None of the species recorded by this project are new records for mammals on the Bonaparte

Table 1. The island and mainland locations and their co-ordinates sampled during the Bonaparte Archipelago surveys of 2002–2005. The island areas, dates and duration of sampling, number of trap days and broad geological substrates are listed.

ISLAND	AREA (ha)	DATES	Days	Trap days	Latitude	Longitude	Geology
Berthier	556	28/5–1/06/2004	5	500	14°31'	124°59'	Volcanic
Bigge	18121	3–8/06/2004	6	750	14°36'	125°12'	Sandstone/Volcanic
Bonaparte	19	20/05/2005	1	50	14°51'	124°46'	Sandstone
Boongaree	4840	29–3/06/2005	6	1110	15°05'	125°10'	Sandstone/Volcanic
Buffon	283	22–23/05/2005	2	226	14°54'	124°44'	Volcanic
Capstan	394	2–5/06/2004	4	350	14°35'	125°15'	Sandstone
Carlia	457	3–6/09/2002	4	330	14°22'	126°00'	Sandstone/Volcanic
Cassini	370	25–26/08/2002	2	400	13°57'	125°38'	Laterite/Volcanic
Colbert	100	19–20/05/2005	2	200	14°52'	124°43'	Sandstone
Cornelle	299	27–30/08/2002	4	400	14°11'	125°44'	Laterite/Volcanic
Coronation	4125	24–28/05/2005	5	716	15°02'	124°57'	Volcanic
Descartes	159	29–30/08/2002	2	120	14°10'	125°41'	Volcanic
Don	73	26–27/05/2004	2	80	14°16'	125°19'	Volcanic
Fenelon	253	27–30/08/2002	4	400	14°08'	125°42'	Laterite/Volcanic
Glauert	1023	24–26/05/2006	3	225	15°03'	124°57'	Volcanic
Grey	399	24–26/05/2005	3	225	15°02'	124°57'	Volcanic
Hedley	172	21–23/05/2005	3	300	14°57'	124°40'	Sandstone
Keraudren	129	21–23/05/2006	3	300	14°56'	124°41'	Volcanic
Kidney	227	2–4/09/2002	3	137	14°20'	125°59'	Volcanic
La Fontaine	158	26–28/08/2002	3	120	14°09'	125°47'	Sandstone
Low Rocks	4	28/08/2002	0.5		14°03'	125°52'	
Mainland – Scott Strait		2–8/06/2004	6	1000	14°36'	125°15'	
Mainland – Prince Regent NR		25/5–3/06/2005	9	1063	15°05'	125°07'	
Maret North	400	28–1/06/2004	5	660	14°23'	124°59'	Laterite/Volcanic

Maret South	384	29-1/06/2004	4	400	14°27'	124°59'	Laterite/Volcanic
McCulloch	6	21/05/2005	0.5		14°56'	124°40'	Volcanic
Montalivet East	366	26-27/05/2004	2	300	14°17'	125°18'	Laterite/Volcanic
Montalivet West	337	26-27/05/2004	2	200	14°18'	125°13'	Laterite/Volcanic
Osborn Middle	2455	2-5/09/2002	4	304	14°21'	126°01'	Volcanic
Osborn South-West	1315	31-5/09/2002	6	659	14°23'	125°57'	Sandstone/Volcanic
Parry	52	31/08/2002	0.5		14°20'	125°46'	Sandstone
Purrungku	1389	6-8/06/2004	3	150	14°37'	125°14'	Sandstone
Steep Head	278	6/09/2002	1	20	14°27'	126°00'	Sandstone
Unnamed	23	6-8/06/2004	3	150	14°36'	125°14'	Volcanic
Walker	62	26-27/05/2004	2	80	14°17'	125°19'	Volcanic
Whitley	41	22-23/05/2005	2	80	14°56'	124°41'	Volcanic
Woodward	29	19-20/05/2005	2	100	14°51'	124°44'	Sandstone

Archipelago, although these findings represent the first records of mammals for Cassini, Capstan, East Montalivet, 'unnamed' and Purrungku Islands. The documentation of *Melomys burtoni* and *Taphozous georgianus* on Coronation and *Zyromys woodwardi* on Carlia Islands are also first records.

The capture of two individuals of *Z. woodwardi* on Coronation Island will allow a thorough examination of the systematic identity of this aberrant population. McKenzie *et al.* (1978) identified this population as 'unusually large' and distinctively coloured *Zyromys argurus* when compared to adjacent mainland populations and stated that the population warranted further systematic examination. Subsequent examination of those individuals by Norah Cooper (pers comm.) clearly demonstrates that they are a small form of *Z. woodwardi*. The two *Isodon* species were recorded only on mainland sampling locations. One mummified skeleton of *Pteropus scapulatus* was located on Cassini Island and probably represents a vagrant, as no roosting site was evident in the very low Eucalypt woodland that occupies the south-eastern part of the island.

The Federal Government recently listed the Northern Quoll, *Dasyurus hallucatus*, as a threatened taxon. This species remains relatively widespread and abundant in the northwest



Table 2. Mammal individuals captured (including those vouchered in brackets) from the Bonaparte Archipelago surveys 2002–2005 and the confirmed sightings (S) of larger species.

Species	BIGGE	BOONGAREE	CAPSTAN	CARLIA	CASSINI	CORONATION	MAINLAND SCOTT STRAIT	MAINLAND PRINCE REGENT	EAST MONTALIVET	MIDDLE OSBORN	SOUTH WEST OSBORN	PURRUNKU	"UNNAMED"	TOTAL
<i>Tachyglossus aculeatus</i>		S												S
<i>Dasyurus hallucatus</i>	12(2)	14(0)	6(1)				11(1)	9(1)				2(1)		54(6)
<i>Isodon auratus</i>							1(1)							1(1)
<i>Isodon macrourus</i>								7(3)						7(3)
<i>Petrogale</i> sp		S												S
<i>Melomys burtoni</i>		3(3)				1(1)		1(1)						5(5)
<i>Mesembriomys macrurus</i>								2(2)					1(1)	3(3)
<i>Rattus tunneyi</i>		6(5)					17(10)	93(12)					1(1)	107(28)
<i>Zyomys woodwardi</i>	12(9)	31(17)	9(8)	5(5)		2(2)	12(8)	10(10)	1(1)	6(4)	63(14)	17(12)	1(1)	168(90)
<i>Zyomys argurus</i>							26(23)	12(11)				3(2)		41(36)
<i>Pteropus scapulatus</i>					1(1)									1(1)
<i>Vespadelus douglasorum</i>		1(1)												1(1)
<i>Taphozous georgianus</i>		6(6)			2(2)									6(6)

Kimberley and occurs on several larger near-shore islands (Abbott and Burbidge 1995). During the current expeditions there were six instances of the Northern Quoll being captured in traps with partially eaten rodent species that indicate the quolls entered the traps in order to eat the rodent. The rodents involved were *Rattus tunneyi*, *Zyromys argurus* and *Z. woodwardi*.

Larger islands generally had more species while smaller islands usually lacked mammal populations, although of particular interest is the discovery of two mammal species on 'unnamed' island in Scott Straight. This island is just over 23 hectares and its ability to support both *Rattus tunneyi* and *Mesembriomys macrurus* is surprising. Four islands with mammal species, Carlia, Boongaree, Capstan and Purrungku, are separated from the mainland by less than 100 metres of water and the latter two may be connected to the mainland at extreme spring low tides. It is remarkable that a population of *Zyromys* was found on East Montalivet, given its large distance from the mainland (30 km), as there appears little likelihood that this population represents anything other than a long-isolated relictual one. Augustus Island is the only offshore location where both species of *Zyromys* co-occur and gives credence to the statement that 'Wetter conditions at the time of isolation of the

Kimberley islands may have influenced the distribution of the two species of *Zyromys*' (McKenzie *et al.* 1978).

The survey of the Bonaparte Archipelago in the early 1970s (McKenzie *et al.* 1978) recorded 22 native mammal species from 20 islands. Foremost amongst the islands for mammal diversity was Augustus Island, the largest, on which 11 species were recorded, while Bigge had eight species and Boongaree nine. Although six days were spent sampling on Bigge during the present project, only two species of mammal were recorded (Table 2). No attempt was made to systematically sample bats throughout the expeditions and these accounted for 5 of the native species recorded by McKenzie *et al.* (1978).

There has been continuing interest in the extinction rates of Australian mammal species in the temperate and arid areas of the continent. It has been postulated that mammals in a 'critical weight range' of 35g–5.5kg have higher extinction rates than those outside this range (Burbidge and McKenzie 1989). However, mammals that are both smaller and larger than those in the 'critical weight range' do not appear to persist well on offshore Kimberley Islands. The North Kimberley bioregion of Western Australia is one of the few areas where the original mammal fauna remains intact with no recorded extinctions. Excluding bats and

all exotic species, one of the five (20%) ground mammals above the critical weight range in the North Kimberley bioregion [*Canis lupus*] has been recorded on several islands of the Bonaparte Archipelago and two of the eight (25%) mammals below the 'critical weight range' are also known on Bonaparte islands [*Pseudantechinus ningbing* on Augustus and South Heywood and *Pseudomys delicatulus* on Bigge]. The six other smaller mammal species known from the North Kimberley mainland but not the islands are, *Planigale maculata*, *P. ingrami*, *Sminthopsis virginiae*, *S. butleri*, *Leggadina lakedownensis* and *Pseudomys laborifex* (Kitchener *et al.* 1981, McKenzie *et al.* 1975). Fourteen of the 21 (66%) terrestrial mainland North Kimberley mammals within the 'critical weight range' occur on Bonaparte islands (McKenzie *et al.* 1978). Given the supposedly greater persistence amongst smaller mammal species in other parts of mainland Australia, it is surprising that so few survive on Bonaparte islands compared with those known from the adjacent north Kimberley mainland. A recent re-examination of the purported higher extinction rates amongst 'critical weight range' mammals (Cardillo and Bromham 2001) suggests that this is not supported statistically and indicates a more significant issue is the higher persistence of smaller mammal species across mainland Australia in the face of a general decline in mammal

species. Such is not the case in the Bonaparte Archipelago.

The present and previous island surveys in the Kimberley occupied limited timeframes and were often constrained by the difficult and remote terrain. Intensive ecological studies of the Mitchell Plateau mammal fauna in the north Kimberley (Bradley *et al.* 1987) showed the advantages of a longer-term seasonal and habitat focussed approach to regional survey by adding several species to the previously known vertebrate assemblages of an intensively sampled mainland location (Kitchener *et al.* 1981). It is highly probable that additional species of mammals will be located on islands that have already been sampled as evidenced by the discovery of *Z. woodwardi* on East Montalivet and several additional species recorded for Bigge by a CALM survey in 2003. The long occupancy of Koolan Island for mining purposes has also shown that continued sampling and observation results in higher diversity of mammals with 18 mammals now known to occur there.

## REPTILES

Reptile species were recorded on all 35 islands and the two adjacent mainland locations. None of the 29 species recorded were found only at the mainland locations, which are omitted from Table 3. All 1200 individuals captured and identified had tissue sampled.

These data represent the first

sampling of reptiles on Berthier, Bonaparte, Buffon, Capstan, Cassini, Colbert, Corneille, Descartes, Don, Glauert, Grey, Hedley, Keraudren, Kidney, La Fontaine, Low Rocks, McCulloch, North Maret, Parry, Purrungku, South Maret, Steep Head, 'unnamed', Walker, West Montalivet, Whitley and Woodward Islands.

Several species were collected that had not previously been recorded from islands in the Bonaparte Archipelago, *Heteronotia planiceps*, *Cyclodomorphus maximus*, *Lerista* sp., *Tiliqua scincoides*, and *Dendrelaphis punctulata* (Smith and Johnstone 1978; WA Museum records). All these taxa have been recorded from islands in the Buccaneer Archipelago but represent the first recorded island populations in the Bonaparte Archipelago. Clearly, there is still need for detailed biodiversity survey initiatives on islands in this diverse archipelago.

One of the most important 'finds' of the sampling has been the discovery of an undescribed *Lerista* species from Berthier Island. The closest taxon to this in the WA Museum collections is *Lerista praefrontalis*, a unique population on King Hall Island in the Buccaneer Archipelago. The *Lerista* specimens from Berthier Island are in need of detailed systematic assessment (Maryan pers comm.). Offshore island populations of the Olive Python *Liasis olivaceus*, were

discovered on Descartes (159 ha) and Don (73 ha) Islands, indicating the species is far more widespread than previously thought and that it can persist on relatively small islands in the absence of mammals; presumably both reptiles and birds comprise their entire diet. The King Brown or Mulga Snake, *Pseudechis australis*, was captured on several islands (Table 3) and were noticeably different in patterning from mainland forms. One individual of this species was captured in a trap and regurgitated a recently killed *Ctenotus inornatus*, also indicating willingness by this predator to enter traps to feed on prey.

Forty-two reptile species were recorded from the Bonaparte archipelago islands by Smith and Johnstone (1978) during the major survey of the early 1970s, however their data included four species only located on Koolan Island, in the Buccaneer Archipelago. The lower number of reptile species on islands compared to adjacent mainland locations (Storr and Smith 1975; Smith and Johnstone 1981) may reflect a true impoverishment of island reptile faunas or a decreased sampling effort on islands. Inadequate sampling effort is best exemplified by the fact that 13 sampling days on Augustus Island, covering 19 023 hectares, yielded 21 reptile species, while long-term records from Koolan Island, covering just 2580 hectares, yielded 35 reptile taxa (McKenzie *et al.* 1995).



**Table 3.** Reptiles recorded from islands sampled in the Bonaparte Archipelago between August 2002 and June 2003.

GENUS	SPECIES	BETHIER	BIGGE	BONAPARTE	BOONGAREE	BUFFON	CAPSTAN	CARLIA	CASSINI	COLBERT	CORNEILLE	CORONATION	DESCARTES	DON
<i>Diporiphora</i>	<i>superba</i>				X									
<i>Pogona</i>	<i>microlepidota</i>		X											
<i>Gehyra</i>	<i>nana</i>		X								X		X	
<i>Gehyra</i>	<i>xenopus</i>						X							
<i>Heteronotia</i>	<i>binoei</i>	X	X	X					X	X			X	
<i>Heteronotia</i>	<i>planiceps</i>				X									
<i>Oedura</i>	<i>obscura</i>				X									
<i>Oedura</i>	<i>rhombifera</i>													
<i>Delma</i>	<i>borea</i>				X							X		
<i>Lialis</i>	<i>burtonis</i>				X									
<i>Carlia</i>	<i>johnstonei</i>	X	X		X	X	X	X			X	X	X	
<i>Carlia</i>	<i>sp.</i>						X	X	X		X		X	X
<i>Carlia</i>	<i>triacantha</i>		X			X				X				X
<i>Cryptoblepharus</i>	<i>megastictus</i>													
<i>Cryptoblepharus</i>	<i>plagiocephalus</i>		X									X		
<i>Ctenotus</i>	<i>inornatus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Cyclodomorphus</i>	<i>maximus</i>													
<i>Glaphyromorphus</i>	<i>isolepis</i>	X		X		X			X			X		
<i>Lerista</i>	<i>sp.</i>									X				
<i>Lerista</i>	<i>walkeri</i>		X											
<i>Morethia</i>	<i>ruficauda</i>											X	X	
<i>Notoscincus</i>	<i>ornatus</i>		X											
<i>Tiliqua</i>	<i>scincoides</i>													
<i>Varanus</i>	<i>acanthurus</i>		X			X					X			
<i>Varanus</i>	<i>glauerti</i>						X							
<i>Antaresia</i>	<i>childreni</i>	X							X					
<i>Liasis</i>	<i>olivaceus</i>												X	X
<i>Dendrelaphis</i>	<i>punctulata</i>									X				
<i>Pseudechis</i>	<i>australis</i>					X		X		X				
TOTAL TAXA		5	10	3	7	6	5	4	5	4	7	6	7	4

EAST MONTALIVET	FENELON	GLAUERT	GREY	HEDLEY	KERAUDREN	KIDNEY	LA FONTAINE	LOW ROCKS	MCCULLOCH	MIDDLE OSBORN	NORTH MARET	PARRY	PURRUNKHU	SOUTH MARET	SOUTH WEST OSBORN	STEEP HEAD	"UNNAMED"	WALKER	WEST MONTALIVET	WHITLEY	WOODWARD
	X	X		X	X						X			X	X			X			
					X					X	X										
X																	X				
	X		X	X	X		X			X	X		X		X	X			X		
X	X					X					X				X				X		
X	X									X	X				X	X		X	X		
					X					X											
X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X
X	X	X		X	X					X					X						
X	X										X		X								
					X					X	X	X							X		
						X															
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	X										X			X						X	
8	7	3	3	5	8	5	1	1	1	8	12	1	3	3	8	2	2	4	6	3	1

## CONCLUSIONS

While the three expeditions to numerous islands in the Bonaparte Archipelago have provided important new records of species on islands, their vertebrate fauna remain poorly documented when compared to Koolan Island in the adjacent Buccaneer Archipelago. Most island populations have not been evaluated systematically and all have the potential to provide important new information on evolutionary effects of isolation since the Pleistocene. Future molecular studies of island populations will document genetic variability though the Archipelago and contrast that with adjacent mainland populations as well as examine the effect of distance from potential source populations.

It has been postulated that the recent population declines of several vertebrate groups in tropical Australia are the result of environmental modifications caused by climate change and lowered groundwater levels (Braithwaite and Muller 1997). This has been questioned by Woinarski *et al.* (2001) who suggested a combination of habitat modification resulting from grazing, altered fire regimes, particularly changing the shrublayer of tropical savannas, as well as predation from feral cats was probably responsible. There is growing evidence that there are long-term changes occurring in mammal populations in the remote Kimberley

mainland in Western Australia (Kenneally *et al.* 2003; Lochman pers comm.).

Islands are likely to be the refugia of the same or closely related taxa on the mainland but are less subjected to anthropogenic influences such as changed fire regimes, cattle grazing and feral cat predation. However, the marked increase in ecotourism of the region has the potential to dramatically alter island species richness. Anecdotal evidence from a professional fisherman suggests there has been a three-fold increase in the number of tour boats cruising the Kimberley coast since 2002 (Macintosh pers comm.).

The most significant threat to island populations may come from the colonisation of the Kimberley by *Bufo marinus*, the Cane Toad. This threat will occur either naturally, by the colonisation of the islands by this invasive pest, or by misguided introductions to islands of mainland forms that are perceived to be threatened by the spread of *Bufo* across the mainland.

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## REFERENCES

- ABBOTT, I. and BURBIDGE, A. A. 1995. The occurrence of mammal species on the islands of Australia: a summary of existing knowledge. *CALM Science*, 1: 259–324.
- BRADLEY, A.J., KEMPER, C.M., KITCHENER, D.J., HUMPHREYS, W.F. and HOW, R.A. 1987. Small mammals of the Mitchell Plateau Region, Kimberley, Western Australia. *Australian Wildlife Research*, 14: 397–413.
- BRAITHWAITE, R and MULLER, W.J. 1997. Rainfall groundwater and refuges: Predicting extinctions of Australian tropical mammal species. *Australian Journal of Ecology*, 22: 57–67.
- BURBIDGE, A. A. and McKENZIE, N. L. Eds. 1978. The Islands of the North-west Kimberley. *Wildlife Research Bulletin of Western Australia*, 7.
- BURBIDGE, A. A. and McKENZIE, N. L. 1989. Patterns in the modern decline of Western Australia's vertebrate fauna: Causes and conservation implications. *Biological Conservation*, 50: 143–198.
- CARDILLO, M. and BROMHAM, L. 2001. Body size and risk of extinction in Australian mammals. *Conservation Biology*, 15: 1435–1440.



- DAHL, K. 1897. Biological notes on North-Australian Mammalia. *Zoologist Ser.* 4, 1:189–216.
- GOVERNMENT OF WESTERN AUSTRALIA 2005. *Wildlife Conservation (Specially Protected Fauna) Notice 2005*, published in *Government Gazette* 8th Feb 2005, pp 648–656
- HOPPER, S. D., HARVEY, M. S., CHAPPILL, J A., MAIN A. R. and MAIN B. Y. 1996. The Western Australian biota as Gondwanan heritage – a review. In: (eds S D Hopper, J A Chappill, M S Harvey & A S George). Surrey Beatty & Sons, Chipping Norton, 1–46.
- HOW, R.A. and COWAN, M.C. 2006. Collections in space and time: A biogeographical examination of native frogs, mammals and reptiles in Western Australia. *Pacific Conservation Biology* (in press).
- HOW, R.A., PEARSON, D J., DESMOND, A and MARYAN, B. 2004. Reappraisal of the reptiles on the islands of the Houtman Abrolhos, Western Australia. *Western Australian Naturalist*, 24: 172–178.
- KABAY, E.D. and BURBIDGE, A.A. (Eds.) 1977. A biological survey of the Drysdale River National Park North Kimberley, Western Australia. *Western Australian Wildlife Research Bulletin*, 6.
- KENNEALLY, K., EDINGER, D., COATE, K., HYLAND, B., HOW, R., SCHMITT, L., COWAN, M., WILLING, T. and DONE, C. 2003. *The Last Great Wilderness – Exploration of the Mitchell Plateau* 2002. LANDSCOPE Expedition Report No. 49, CALM, Perth, WA. 32pp.
- KITCHENER, D.J. 1976. *Eptesicus douglasi*, a new vespertilionid bat from Kimberley, Western Australia. *Records of the Western Australian Museum*, 4: 295–301.
- KITCHENER, D.J. 1978. Mammals of the Ord River Area, Kimberley, Western Australia. *Records of the Western Australian Museum*, 6: 189–219.
- KITCHENER, D.J. 1989. Taxonomic appraisal of *Zyomys* (Rodentia, Muridae) with descriptions of two new species from the Northern Territory, Australia. *Records of the Western Australian Museum*, 14: 331–374.
- KITCHENER, D.J. and CAPUTI, N. 1988. A new species of *False Antechinus* (Marsupialia, Dasyuridae) from Western Australia, with remarks on the generic classification with the *Parantechini*. *Records of the Western Australian Museum*, 14: 35–59.
- KITCHENER, D.J. and HUMPHREYS, W.F. 1986. Description of a new species of *Pseudomys* (Rodentia: Muridae) from the Kimberley Region, Western Australia. *Records of the Western Australian Museum*, 13: 13–25.
- KITCHENER, D.J. and SANSON, G. 1978. *Petrogale burbidgei* (Marsupialia, Macropodidae), a new rock wallaby from Kimberley, Western Australia. *Records of the Western Australian Museum*, 6: 269–285.
- KITCHENER, D. J. and SUYANTO, A. 1996. Intraspecific

morphological variation among island populations of small mammals in southern Indonesia. In: A. Suyanto and D.J. Kitchener (eds.), *Proceedings of the First International Conference on Eastern Indonesia - Australian Vertebrate Fauna*, pp. 7-14. Lembaga Ilmu Pertahanan Indonesia, Jakarta.

KITCHENER, D. J., KELLER, L. E., CHAPMAN, A., McKENZIE, N. L., START, A. N. and KENNEALLY, K. F. 1981. Observations on mammals of the Mitchell Plateau area, Kimberley, Western Australia. Pp123-168 In: *Biological Survey of the Mitchell Plateau and Admiralty Gulf*. Wilson, B. W Ed. Western Australian Museum, Perth.

McKENZIE, N. L. 1981. Mammals of the Phanerozoic South-west Kimberley, Western Australia: Biogeography and recent changes. *Journal of Biogeography*, 8:263-280.

McKENZIE, N. L., CHAPMAN, A. and YOUNGSON, W. K. 1975. Mammals. Pp 69-74. In: Miles, J. M. and Burbidge A. A. Eds. A biological survey of the Prince Regent River Reserve, North-west Kimberley, Western Australia in August 1974. *Wildlife Research Bulletin of Western Australia*, 3.

McKENZIE, N. L., BURBIDGE, A. A., CHAPMAN, A. and YOUNGSON, W. K. 1978. Mammals. Pp 22-28 In: Burbidge A. A. and McKenzie, N. L. Eds. *The Islands of the North-west Kimberley*. *Wildlife Research Bulletin of Western Australia*, 7.

McKENZIE, N. L., FONTANINI, L., LINDUS, N.V. and WILLIAMS, M.R. 1995. Biological inventory of

Koolan Island, Western Australia 2. Zoological notes. *Records of the Western Australian Museum* 17: 249-266.

McKENZIE, N.L., JOHNSTON R.B. and KENDRICK, P.G. Eds. 1991. *Kimberley Rainforests Australia*. Surrey Beatty and Sons, Chipping Norton.

MILES, J. M. and BURBIDGE, A. A. Eds. 1975. A biological survey of the Prince Regent River Reserve, North-west Kimberley, Western Australia in August 1974. *Wildlife Research Bulletin of Western Australia*, 3.

NIX, H. A. and KALMA, J. D. 1972. Climate as a dominant control in the biogeography of Northern Australia and New Guinea. Pp. In: *Bridge and Barrier: the Natural and Cultural History of Torres Strait*. Walker, D. Ed. Research School of Pacific Studies Publication B6/3. Australian National University Canberra.

RIDE, W.D.L. and TYNDALE-BISCOE, C.H. 1962. Mammals. In: *An Expedition to Bernier and Dorre Islands*. A.J. Fraser Ed. *Western Australian Fisheries Department Fauna Bulletin*, 2: 54-97.

SCHMITT, L.H., KITCHENER, D.J. and HOW, R.A. 1995. A genetical perspective of mammalian variation and evolution in the Indonesian Archipelago: Biogeographic correlates in the fruit bat genus, *Cynopterus*. *Evolution*, 49: 399-412.

SMITH, L. A. 1976. Reptiles of Barrow Island. *Western Australian Naturalist*, 13:125-136.

SMITH, L.A. and JOHNSTONE, R.E.

1978. Amphibians and Reptiles. Pp 42–45. In: Burbidge A. A. and McKenzie, N. L. Eds. The Islands of the North-west Kimberley. *Wildlife Research Bulletin of Western Australia*, 7.
- SMITH, L.A. and JOHNSTONE, R.E. 1981. Amphibians and reptiles of Mitchell Plateau and adjacent coasts and lowlands, Kimberley, Western Australia. Pp 215–217. In: *Biological Survey of the Mitchell Plateau and Admiralty Gulf*. Wilson, B. W. Ed. Western Australian Museum, Perth.
- STORR, G.M. 1975. The genus *Ctenotus* (Lacertilia: Scincidae) in the Kimberley and North-West divisions of Western Australia. *Records of the Western Australian Museum* 3: 167–208.
- STORR, G. M. 1980. Birds of the Kimberley Division, Western Australia. *Western Australian Museum Special Publication No. 11*.
- STORR, G. M and SMITH, L.A. 1975. Amphibians and reptiles. Pp 89–96. In: Miles, J. M. and Burbidge A. A. Eds. A biological survey of the Prince Regent River Reserve, North-west Kimberley, Western Australia in August 1974. *Wildlife Research Bulletin of Western Australia*, 3.
- WESTERN AUSTRALIAN MUSEUM 1981. *Biological survey of the Mitchell Plateau and Admiralty Gulf, Kimberley, Western Australia*. Western Australian Museum, Perth.
- WOINARSKI, J.C.Z., MILNE, D. J. and WANGANEEN, G. 2001. Changes in mammal populations in relatively intact landscapes of Kakadu National Park, Northern Territory, Australia. *Austral Ecology*, 26: 360–370.